



SIM approach as the RMO of the Americas

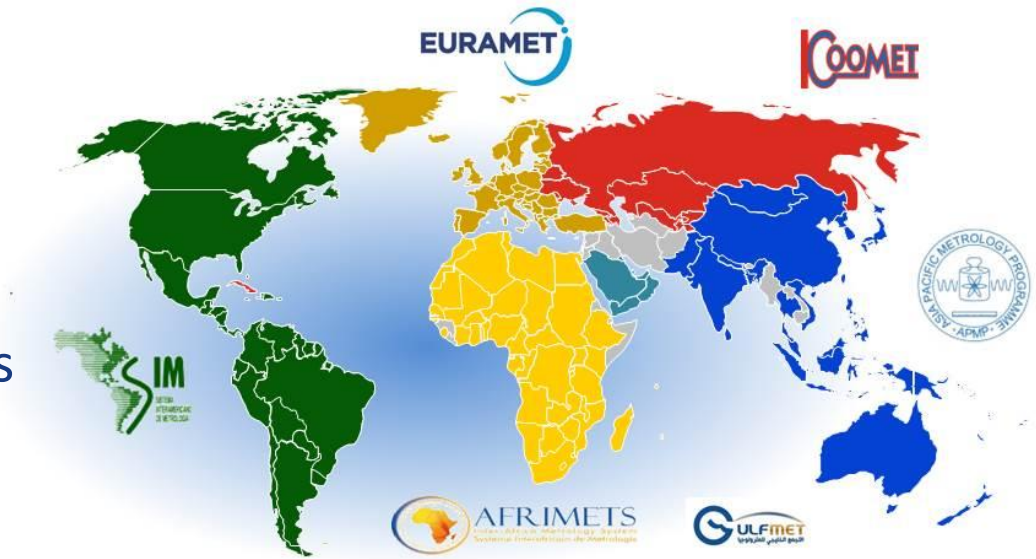
Sally Bruce, Quality Manager for
NIST Measurement Services

Bureau
♦ **I**nternational des
♦ **P**oids et
♦ **M**esures



RMOs Regional Metrology Organizations

- ♦ Run RMO key comparisons and supplementary comparisons to support the CIPM MRA
- ♦ Participate in the JCRB
- ♦ Validate NMI Quality Systems
- ♦ Review NMI Calibration and Measurement Capability Statements (CMCs)



Each RMO has Metrology Working Groups that mirror the CIPM Consultative Committees

Outline

- ◆ Brief history, Overview of the Structure and Organization of SIM
- ◆ Current Projects with SIM
- ◆ Participation in the CIPM MRA
 - SIM Procedure for registration of comparisons
 - SIM Guidance for submission of quality systems
 - SIM Guidance for the submission of the CMC's
- ◆ Intercomparisons and Measurement Capabilities within SIM

History of SIM

- ♦ The idea of an Inter-American metrology project started in the early 1970's.
- ♦ As part of the special project on metrology, the Inter-American Metrology System (SIM) was created in 1979.
- ♦ During the Summit of the Americas, held in Miami in 1994, the Presidents of the Americas issued a Declaration of Principles, emphasizing economic integration and free trade, through a reduction of technical barriers and promotion of technical cooperation programs on metrology and standards.
- ♦ The Organization of American States, NIST, PTB, and many other institutions have contributed to the creation and implementation of SIM.



Organización de los Estados Americanos
Organização dos Estados Americanos
Organisation des États Américains
Organization of American States



The original building of the OAS next to the current building, located in Washington DC.

SIM Today

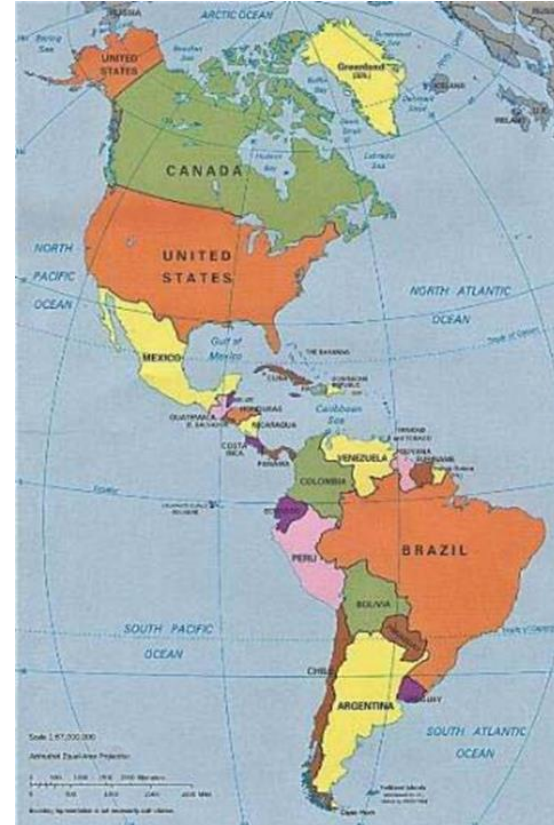


Membership: National Metrology Institutes (NMIs) in 34 nations in the Americas

Mission: To promote and support an integrated measurement infrastructure in the Americas that ensures equity in the marketplace, improves the quality of life and facilitates international trade.

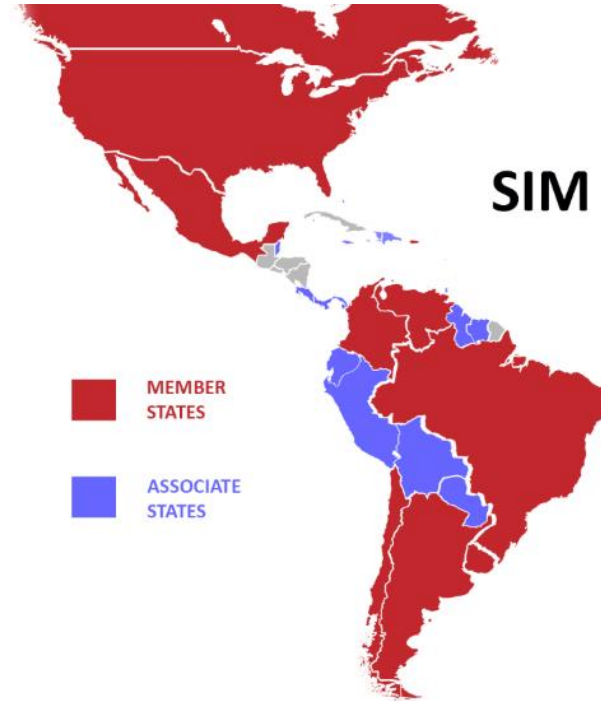
International Role: Regional Metrology Organization (RMO) for the Western Hemisphere within the framework of the Committee on Weights and Measures Mutual Recognition Arrangement (CIPM MRA):

- ◆ Review and approve Quality Systems (QSTF)
- ◆ Review and approve CMC claims
- ◆ Organize regional key and supplementary comparisons



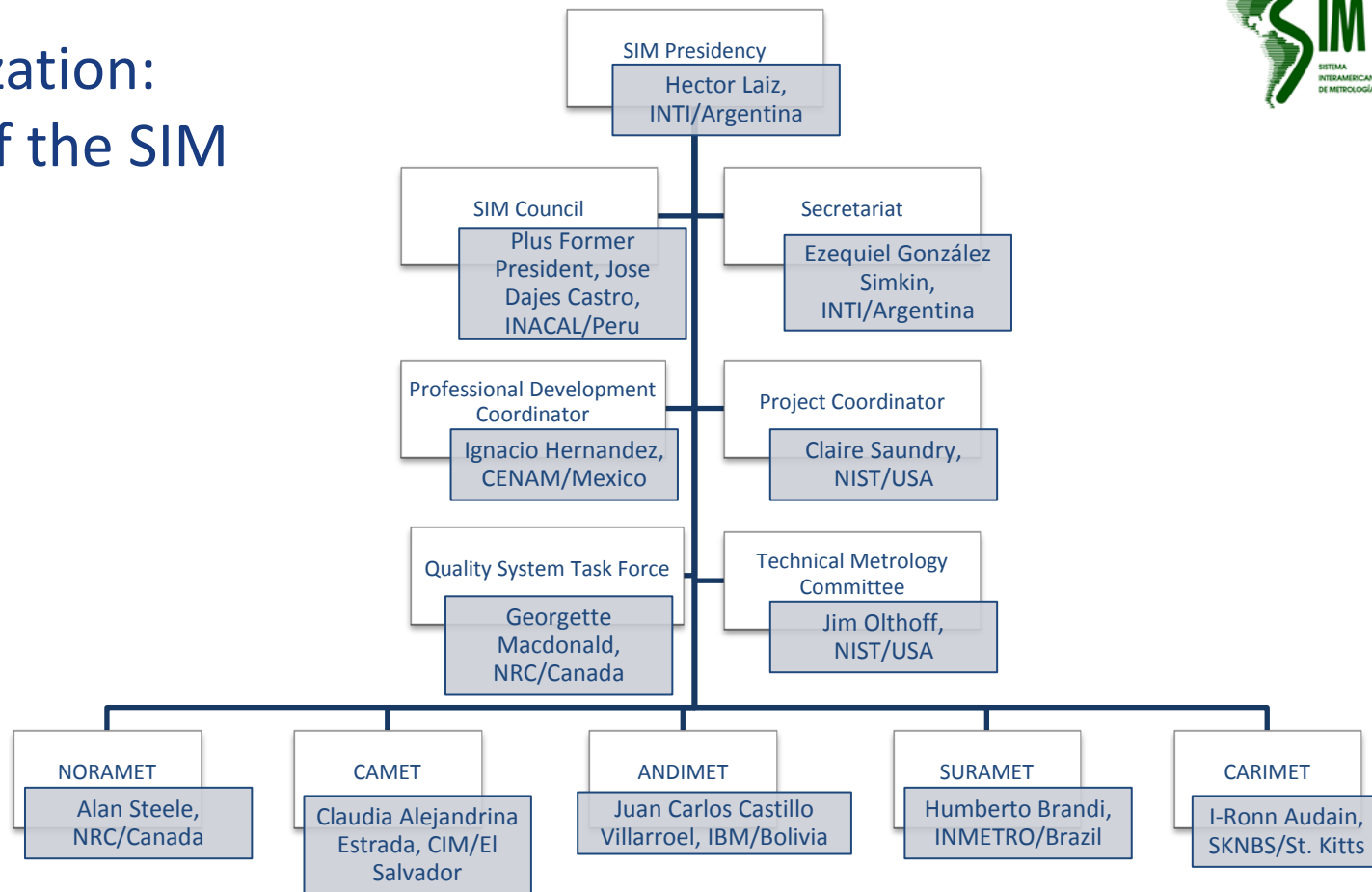
Participation in the Treaty of the Meter/CIPM MRA

- ♦ 9 member states
- ♦ 8 Associate members of the CGPM (including CARICOM which represents 11 Institutions)
- ♦ 16 MRA signatories (including CARICOM)
- ♦ 20 Designated Institutes





SIM Organization: Members of the SIM Council



SIM Technical Committee: Measurement Working Groups



- ♦ **MWG 1: Electricity and Magnetism (EM)**

Chair: Lucas di Lillo

INTI/Argentina

- ♦ **MWG 2: Photometry and Radiometry (PR)**

Chair: Thiago Menegotto

INMETRO/Brazil

- ♦ **MWG 3: Thermometry (T)**

Chair: Edgar Méndez

CENAM/ México

- ♦ **MWG 4: Length (L)**

Chair: Karina Bastida

INTI/ Argentina

- ♦ **MWG 5: Time and Frequency (TF)**

Chair: Raúl Solís

CENAMEP/Panamá

- ♦ **MWG 6: Ionizing Radiation and Radioactivity (RI)**

Chair: Lisa R. Karam

NIST/USA

- ♦ **MWG 7: Mass & Related Quantities (M)**

Chair: Aldo Quiroga

INDECOPI/Peru

- ♦ **MWG 8: Chemistry, Amount of Substance, Quantities of the Mole, (QM)**

Chair: Valnei Da Cunha

INMETRO/Brazil

SIM Technical Committee: Measurement Working Groups



- ♦ **MWG 9: Acoustics, Ultrasound and Vibration (AUV)**

Chair: Gustavo Ripper

INMETRO/Brazil

- ♦ **MWG 10: Flow and Volume**

Chair: Roberto Arias

CENAM/Mexico

- ♦ **MWG 11: Legal Metrology Working Group**

Chair: Raimundo Razende

INMETRO/Brazil

- ♦ **MWG 12: Quality System**

Chair: Gabriela de la Guardia

CENAMEP/Panamá

- ♦ **MWG 13: Statistics and Uncertainty**

Chair: Antonio Possolo

NIST/USA

- I. Develop SIM NMIs**
- II. Building a Strong SIM Organization**
- III. Fulfill Regional Metrology Organization Obligations under the CIPM MRA**

Current SIM Projects & their support



Inter-American Development Bank (IADB)

- Strengthening National Metrology Institutes in the Hemisphere, in support of Emerging Technologies (Managed by INTI)

Organization of American States (OAS)

- Advancing Metrology for Sustainable Energy Technologies and Climate Science on the Western Hemisphere (Managed by NIST)
- Advancing Metrology for Energy Efficient Measurements and Compliance in Central America and the Dominican Republic (Managed by NIST)

National Institute of Standard and Technology (NIST)

- Capacity Building and Research Exchanges

Physikalisch-Technische Bundesanstalt (PTB)

- Quality Infrastructure (QI) for Renewable Energy Sources and Energy Efficiency
- Develop QI Service for Biodiversity and Climate Change
- Capacity Building in technical and scientific Organizations using regional Experiences and Knowledge (CABUREK)
- Promoting Innovation in the Green Economy by including QI



Development of SIM NMIs



- ♦ **Develop Metrology for Innovation**
 - Emerging technologies
 - ♦ Resources: IADB Project, NIST Project
- ♦ **Develop Metrology for a Sustainable Development**
 - Renewable Energies, Energy Efficiency, Climate Science, Biodiversity and Green Economy
 - ♦ Resources: PTB Project, OAS Projects, NIST Project
- ♦ **Increase the technical capabilities of SIM NMIs**
 - Courses, workshops and internships
 - ♦ Resources: NIST Program, PTB Project CABUREK, BIPM CBKT Program
- ♦ **Implementation of the redefinition of the SI in the region**
 - ♦ Resources: SIM NMIs, NIST-NRC Project

NIST-sponsored SIM Capacity Building and Research Exchange



Hands-on Metrology Courses at NIST (2016-2017)

- ◆ Fundamentals of Metrology (week long)
- ◆ Temperature and Uncertainty
- ◆ Dimensional Metrology
- ◆ Photometry and Radiometry
- ◆ Time and Frequency
- ◆ Analytical Chemistry and Clinical Methods
- ◆ Gas and Liquid Flow

Additional Training (off-site)

- ◆ BIPM Sound Beginning in the CIPM MRA (Nov 2017)
- ◆ BIPM Leaders of Tomorrow (2016)
- ◆ CPEM (2016)
- ◆ NCSLI Tech Exchange (2017)

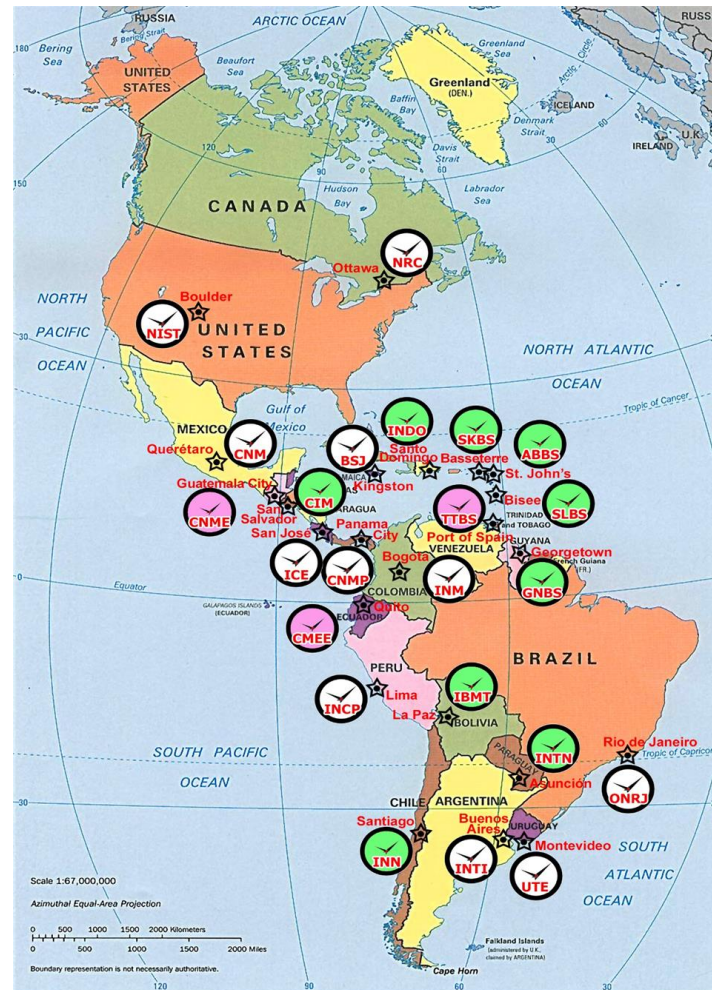
Guest Researchers from SIM NMI's to NIST

- ◆ 2016 (12 from 6 countries)
- ◆ 2017 (13 from 6 countries)



NIST-sponsored SIM Time Scale (SIMT)

- ♦ Generated in real-time (updated hourly)
- ♦ Good approximation of UTC (+/- 15 ns)
- ♦ Accessible via tf.nist.gov/sim
- ♦ The white clocks represent the SIMT contributors: cesium clocks or hydrogen masers
- ♦ The green clocks represent rubidium clocks disciplined to SIMT, and
- ♦ The purple clocks represent either a GPS disciplined clock or an undisciplined rubidium clock.
- ♦ 25 countries participate



Building a Strong SIM



- ◆ **Implement mutually beneficial interactions**
 - CIPM-BIPM, other RMOs, OIML, NCSLi and the Quality Infrastructure Council of the Americas (QICA)
 - Resources: IADB Project
- ◆ **Improve communications between SIM members**
- ◆ **Establish SIM as a Legal Entity**
- ◆ **Build a financially sustainable institution**
- ◆ **Increase the participation of SIM members in leadership**

Fulfill RMO Obligations of the CIPM MRA



- ◆ Ensure effective international representation of SIM
 - Ensure SIM NMI needs are met by the CIPM MRA
- ◆ Ensure efficient and effective technical review of regional and inter-regional CMCs submitted to the KCDB
- ◆ Ensure efficient and effective review of the QMS of SIM NMIs to ensure compliance with the requirements of the CIPM MRA and serve *other needs* of SIM NMIs
- ◆ Organize and implement regional key comparisons required to support the calibration programs of SIM NMIs and to provide linkage to BIPM key comparisons

SIM-07 DRAFTED POLICY, PROCEDURE FOR REGISTRATION AND DISPOSITION OF SIM COMPARISONS

All current and planned SIM comparisons and pilot studies shall be registered by the Metrology Working Group Chairs in the BIPM KCDB, and shall be carried out in accordance with the Technical Supplement to the CIPM MRA.

Upon request by the comparison Pilot Laboratory, the chair of the MWG will forward requests for registration of comparisons to the relevant Consultative Committee (CC), but it remains the responsibility of the CC to deem acceptance as a CC key (or supplementary) comparison.

Examples of some regional comparisons registered in the KCDB.

<u>SIM.EM- S4.1</u>	Comparison of capacitors 2010 - 2011
Comparison type, Field	Supplementary comparison in Electricity and Magnetism, Capacitance
Parameter(s)	Capacitance: 100 pF
Status	Frequency: 1000 Hz Approved and published
<u>SIM.EM- K6.1</u>	Comparison of AC/DC voltage transfer standards 2012 - 2013
Comparison type, Field	Key comparison in Electricity and Magnetism, AC Voltage, Current, Power, and AC/DC Transfer
Parameter(s)	Voltage: 1.5 V
Status	Frequency: 10 Hz, 1 kHz, 20 kHz, 50 kHz, 100 kHz, and 1 MHz Approved for equivalence, Results available
<u>APMP.M.M- K4.1</u>	Comparison of mass standards 2015
Comparison type, Field	Key comparison in Mass, Mass Standards
Status	Approved for equivalence, Results available
<u>SIM.M.G- K1</u>	Free-fall acceleration 2016
Comparison type, Field	Key comparison in Mass, Gravity
Status	Approved for equivalence, Results available
<u>SIM.M.F- S5</u>	Comparison of a force testing machine 2013
Comparison type, Field	Supplementary comparison in Mass, Force
Status	Approved and published

SIM Intercomparisons, recent examples

Synthetic natural gas (6)

Auto emissions in nitrogen (8)

Liquid Volume (7)

Trace metals in Drinking Water (in coordination with NRC and CENAM, underway)



SIM Intercomparisons registered in 2017



Comparison type and amount (17 total)

Code for type and field

- | | |
|--------------------------------|-----|
| ♦ Photometry & Radiometry -1 | PR |
| ♦ Mass, Standards – 3 | MM |
| ♦ Mass, Density – 1 | M.D |
| ♦ Mass, Pressure- 1 | M.P |
| ♦ Mass, Torque – 1 | M.T |
| ♦ Electricity and Magnetism -1 | EM |
| ♦ Thermometry - 1 | T |



Inter-American
Metrology System

***SIM Quality System Task Force
Delegates from the NMIs:***

*Argentina, Bolivia, Brazil, Canada, Chile,
Columbia, Costa Rica, Ecuador, Jamaica, Mexico,
Panama, Paraguay, Peru, United States, Uruguay*

SIM Quality System Task Force (QSTF)



- ◆ Created in 2002 to provide confidence in the region's Quality Management Systems (QMS)
- ◆ Meets biannually
- ◆ Each QMS reviewed every 5 years for all published calibration and measurement capabilities (CMCs) at face-to-face meetings
- ◆ Review of QMS requires rigorous documentation

SIM QSTF Guidance Documents



Available on the internet:

<http://www.nist.gov/pml/sim.cfm>

QSTF-1 Submission Template (required)

QSTF-2 Presentation Template (optional)

QSTF-3 Checklist for QMS Submission (required)

QSTF-4 Non-Conformity Template (optional)

SIM Procedure for the Review of NMI/DI QMS



- ♦ **SIM 09, Rules of Order for the SIM QSTF**
- ♦ **QSTF-O is in draft – Procedure for the QMS reviews**
(previously a part of SIM 09 – soon to be a separate document)

Available from the same link:

<http://www.nist.gov/pml/sim.cfm>

SIM QSTF Website



- ◆ Example submission
- ◆ Example presentation

Available from the same link:

<http://www.nist.gov/pml/sim.cfm>

Materials for a QSTF Review

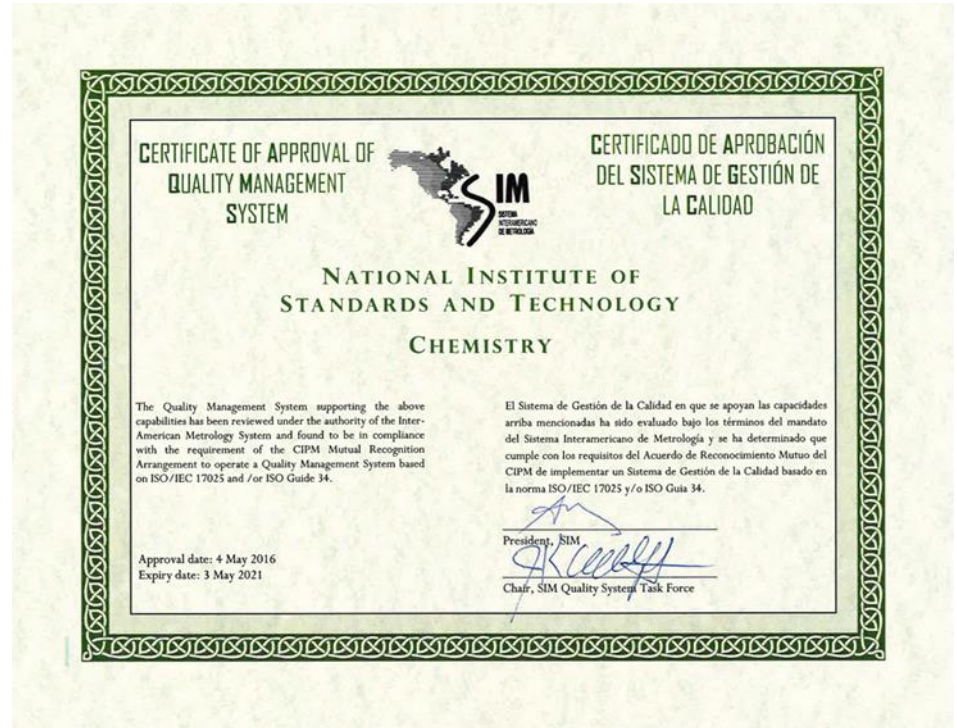
- ◆ Presentation and Written Report that includes the following from the NMI/DI:
 - QMS Policies
 - Organizational charts
 - Customer Feedback Statistics
 - Nonconforming Work Statistics
 - Internal Audit reports
 - Management Reviews
 - Peer Review Reports
 - Findings and Corrective Actions from the Audits, Reviews, and nonconforming work
 - Evidence of Vitality
 - ◆ Improvements
 - ◆ Staffing changes
 - ◆ Publications
 - ◆ Training given/received
 - ◆ Intercomparison performance

Materials for a QSTF Review

- ◆ The following documents:
 - quality manuals
 - Internal Audits
 - Assessment Reports or Peer Review Reports
 - Bios of the Assessors
 - Listing of CMC's under review
 - Technical Procedures
 - Cross reference table between ISO/IEC 17025 and/or ISO Guide 34 or ISO 17034 and the Quality manuals of the NMI or DI

SIM Quality System Task Force (QSTF) Results

- ◆ **Over 200 Quality Management Systems have been approved**



SIM-05 DRAFTED REFERENCE DOCUMENT, PROCEDURE FOR REVIEW OF CALIBRATION AND MEASUREMENT CAPABILITIES SUBMITTED FOR APPENDIX C OF THE CIPM MRA

The SIM review process consists of two parts: a technical review and a quality system review. This document only addresses the technical review.

The CMC's must first be reviewed and approved by the SIM Measurement Working Group.

Once this approval is obtained, the CMC's undergo an interregional review, where Technical Working Groups from other Regions verify that the JCRB Criteria for acceptance of data for Appendix C have been followed. CIPM MRA-D04

- ♦ Use the prescribed formats to enable the interregional review.
- ♦ An Excel template for new CMCs can be downloaded from

http://www.bipm.org/en/committees/jc/jcrb/cmc_excel_files.html

- ♦ General instructions for drawing up the CMC's are found in CIPM MRA-D04 and can be downloaded from
http://www.bipm.org/utils/common/CIPM_MRA/CIPM_MRA-D-04.pdf.

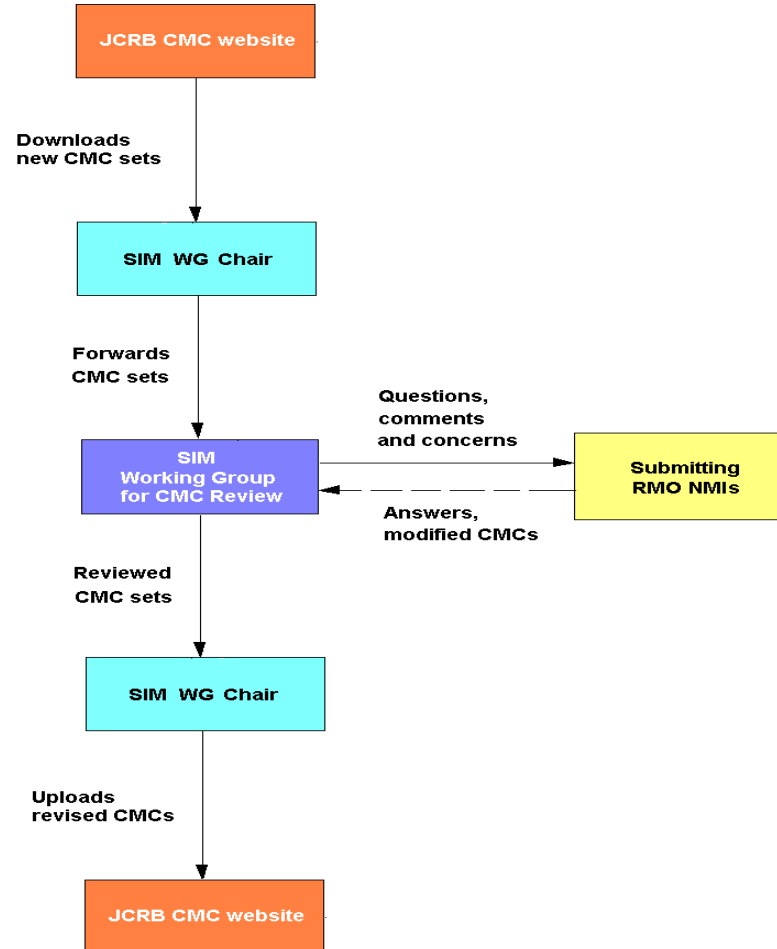
There are two different cases to be taken into consideration:

- New CMCs;
- Modifications to existing, already approved, CMC files

Modifications of a published CMC usually arise for reasons falling into one of three categories:

- a) material or editorial errors and improvements to the explanatory text
- b) increase of the uncertainty or reduction in scope
- c) change of the method of measurement or reduction of the uncertainty or increase in scope.

A simplified flowchart of the CMC Review Process within SIM



Contents and subject matter of the SIM-05

- ♦ Intra-regional Review of CMC's – responsibility of the SIM MWG
- ♦ Time tables for the Intra-regional review
- ♦ Criteria for acceptance of the CMC's by the SIM MWG or from other RMO's
- ♦ SIM Submission for publication of the CMC's in Appendix C of the KCBD
- ♦ Timelines for the interregional review

Intra-regional Review of CMC's – responsibility of the SIM MWG

- ◆ Direct participation is limited to the signatories of the CIPM MRA
- ◆ Submit the CMC's to the SIM MWG Chair
 - ◆ Review begins with their acknowledgement of receipt
- ◆ Reviewed mainly by a group of experts from the signatories appointed by the MWG Chair
- ◆ Review process is expected to finish within 50 calendar days
- ◆ Only CMC's supported by a fully-implemented quality system, reviewed, and approved by SIM QSTF may be submitted for interregional review
 - ◆ Chair of the SIM QSTF would declare this requirement is met

Criteria for Acceptance of CMC's

- ◆ Reviewers check for consistency with the following:
 - ◆ General instruction for drawing up CMC's
 - ◆ Additional instructions including uncertainty matrices
 - ◆ CMC's already published by the NMI, when available

The reviewers will then check the range and uncertainty of the submitted CMCs for consistency with some or all of the following sources:

- ◆ key and supplementary comparisons listed in Appendix B of the KCDB (see <http://kcdb.bipm.org>);
- ◆ other multilateral or bilateral comparisons;
- ◆ knowledge of technical activities of the NMI, including publications or personal knowledge obtained by visits or other means;
- ◆ on-site peer-assessment reports;
- ◆ discussion between the reviewers and responsible scientists within the NMI;
- ◆ performance of equipment currently used

Criteria for Acceptance of CMC's, continued

- ◆ NMIs that do not hold primary standards or primary measurement capabilities are required to have traceability to the SI (or, if not feasible, to another internationally agreed reference) of their national standards or measurement capabilities established through the BIPM or through adequate calibration services of another NMI or other designated institute published in Appendix C of the KCDB (<http://kcdb.bipm.org>).
- ◆ A CMC entry shall not have its traceability based on equipment calibrated by an accredited commercial laboratory, unless the latter is a designated institute listed in Appendix A of the KCDB (<http://kcdb.bipm.org>). However, calibration certificates from such laboratories may be allowed for auxiliary equipment whose contribution exerts a negligible influence on the total expanded uncertainty for the CMC entry.

New and Revised SIM CMC's in 2017



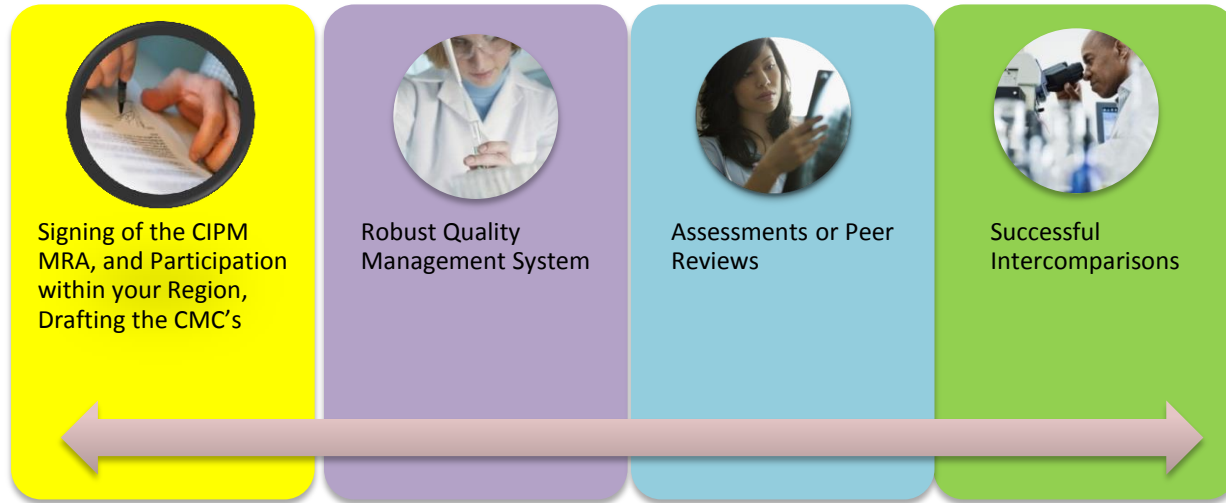
- Acoustics, Ultrasound and Vibration
 - Canada
- Chemistry
 - Argentina, Brazil, Canada, Colombia, Mexico, Peru, USA, Uruguay
- Electricity and Magnetism
 - Brazil, Canada, Panama
- Length
 - Mexico
- Mass and Mass-related quantities
 - Bolivia, Brazil, Canada, Columbia, and Paraguay

Take away messages

- 1) What are the components and steps needed to obtain approval and international recognition of national standards and measurement capabilities under the MRA?
- 2) Why is the International Metrology Infrastructure important? What are the benefits?
- 3) What are the positive outcomes of implementing a Quality Management System for your NMI/DI?



Components for the international recognition/approval of measurement capabilities



The importance of the International Metrology Infrastructure

- ◆ Measurement traceability enables trade and supports manufacturing
- ◆ International approach brings robustness and validity to measurements and supports legal and regulatory requirements
- ◆ Measurements are critical to Innovation
 - ◆ If you know how to measure something, you can design it, improve it, and compare it
 - ◆ Measurement science provides foundation for innovation in every industry and economic sector, from manufacturing to health care



Benefits of the QMS to
the NMI/DI staff and
management

Documentation

Accountability

Improved Customer Service

QUALITY ASSURANCE

Transparency

Succession Planning

Change in Organizational Culture



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**Bureau
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